3.0 EXISTING ENVIRONMENT

Chapter 3:

3.0 Existing Environment

3.1 Physical Environment

3.2 Biological Environment

3.3 Socioeconomic Environment

Section 3.0, Existing Environment, and Section 4.0, Environmental Consequences, are organized by the USEPA general and specific selection criteria for designating an ODMDS (40 CFR 228.5 and 228.6). This organization by criteria is different from the typical NEPA EIS of other federal actions, but the key environmental resources are addressed.

The geographic area described and assessed for each selection criteria/resource area varies. The Region of Influence (ROI) for each resource is a geographic area within which the proposed action may exert some influence. For example, discussions of climate or commercial traffic would cover a large geographic ROI, while bathymetry and sediment discussions would be limited to a narrowly defined ROI, such as the immediate vicinity of alternative ODMDSs located within two study areas. Surveys were conducted by Weston Solutions to obtain measurements of various physical oceanographic and biological parameters. Results of surveys are incorporated into the following discussions of the Physical Environment (Section 3.1) and the Biological Environment (Section 3.2). Physical and chemical parameters measured were selected to provide data on the background concentrations of potential contaminants of concern in the receiving sediments collected from the two study areas, a proposed reference site, and the surrounding study region, in accordance with the guidance document for designation of ODMDS (Pequegnat *et al*. 1990). Current USEPA SW-846 analytical methods were used in chemical analysis (USEPA 2001). The specific sediment analyses and target detection limits are specified in the SAP developed for this project (Weston Solutions and Belt Collins 2007a). Detailed results from these surveys are included in Weston Solutions and TEC (2008b), which comprises the field report resulting from these surveys. Section 3.3 contains a discussion of the Socioeconomic Environment.

3.1 PHYSICAL ENVIRONMENT

The physical environment in the study region includes waters offshore of Guam from the surface to the seafloor and the associated physical and oceanographic characteristics of this environment. The following sections include descriptions of the overall climate and air quality, physical oceanography, characteristics of the water column, regional geology, and characteristics of marine sediments. Gathering information on characteristics of the various physical parameters allows for a determination of baseline conditions that may be affected by dredged material disposal operations.

3.1.1 Climate and Air Quality

3.1.1.1 Climate

The ROI for climate is the general region of Guam, which includes the ODMDS study areas, the Island of Guam, and the offshore area between them. Guam consistently has warm and humid weather, typical of a tropical marine climate. The average daily temperature range is between 76 and 88°Farenheit (°F) (24 and 31°Celcius [°C]). The relative humidity ranges between 65-75% during the day and 85-100% at night (DON 2003). Tradewinds are fairly consistent throughout the year with an average wind speed of 10 miles per hour (mph) (16 kilometers per hour [kph]) from the east (National Weather Service [NWS] 2004). Table 3-1 summarizes the basic meteorological conditions for Guam.

Guam has two primary seasons. The dry season occurs from January to April with a monthly average of 3.25 in (8.3 cm) of rain. July through October comprise the wet season with rainfall averaging approximately 12 inch (in)/month (0.3 m/month) (NWS 2004). The remaining months, May/June and November/December are transitional with no distinct pattern of dry or wet conditions (DON 2003).

Typhoons can occur at any time on Guam; however, they typically occur during the wet months. Typhoons are tropical storms originating in the South Pacific that have sustained winds of at least 75 mph (121 kph). Along with high winds, typhoons bring heavy rains and storm surge. Between the years 1959 and 2007, an annual mean of 31 typhoons occurred in the western North Pacific (U.S. Naval Maritime Forecast Center/Joint Typhoon Warning Center 2007); however, only 19 typhoons passed over Guam in a 57 year span from 1948 to 2005 (i.e. 1 typhoon every 3 years) (Guam Power Authority 2005). In recent years, the frequency of typhoons impacting Guam has risen, with the most devastating occurring in late 2002. Super Typhoon Pongsona occurred on December 8, 2002 with sustained winds greater than 150 mph (241 kph) and gusts exceeding 180 mph (290 kph).

Table 3-1. Summary of Meteorological Conditions for Guam

Weather Elements	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Wind Speed (mph)	11.9	12.8	12.5	12.8	11.3	10.2	8.7	8.3	7.7	8.6	11.1	12.9	10.7
Prevailing Wind Direction (deg. N)	080E	070E	080E	090E	090E	100E	100E	100E	100E	100E	080E	090E	090E
Precipitation (in)	3.91	2.78	2.88	3.46	5.66	5.93	9.83	12.32	14.04	11.69	8.02	5.27	85.78
Mean Temperature (°C)	24	25	26	26	26	27	27	27	26	27	27	26	26.17
Mean Relative Humidity (%)	77	76	75	74	73	76	76	81	81	80	80	78	77.25

3.1.1.2 Air Quality

The ROI for air quality is the general region of Guam, which includes the ODMDS study areas, the Island of Guam, and the offshore area between them. The Clean Air Act (CAA) designated the EPA to establish primary air quality standards to protect public health and secondary air quality standards to protect ecosystems, including plants and animals, and to protect against decreased visibility and damage to crops, vegetation and buildings. The EPA set national ambient air quality standards (NAAQS) for six criteria pollutants which include nitrogen dioxide, ozone, sulfur dioxide, particulate matter, carbon monoxide (CO) and lead. Monitors measure the air quality throughout the country, including U.S. Territories, and determine areas that have met (attainment) or not met (nonattainment) these standards (USEPA 2003).

Guam has “attained” the USEPA’s air quality standards with the exception of two areas classified as nonattainment for sulfur dioxide (SO_2) as of September 1999. These areas are within a 2.2 mi (3.5 km) radius of the Piti Power Plant and the Tanguisson Power Plant (USEPA 2003) (Figure 3-1). The Piti Power Plant is approximately 13.8 nm (25.6 km) south-southeast of the North Study Area and 13.5 nm (25.0 km) southeast of the Northwest Study Area. The Tanguisson Power Plant is approximately 14.9 nm (27.6 km) southeast of the Northwest Study Area and 19.3 nm (35.7 km) east of the Northwest Study Area. None of nonattainment areas around Piti Power Plant or Tanguisson Power Plant encompass either of the proposed study areas.

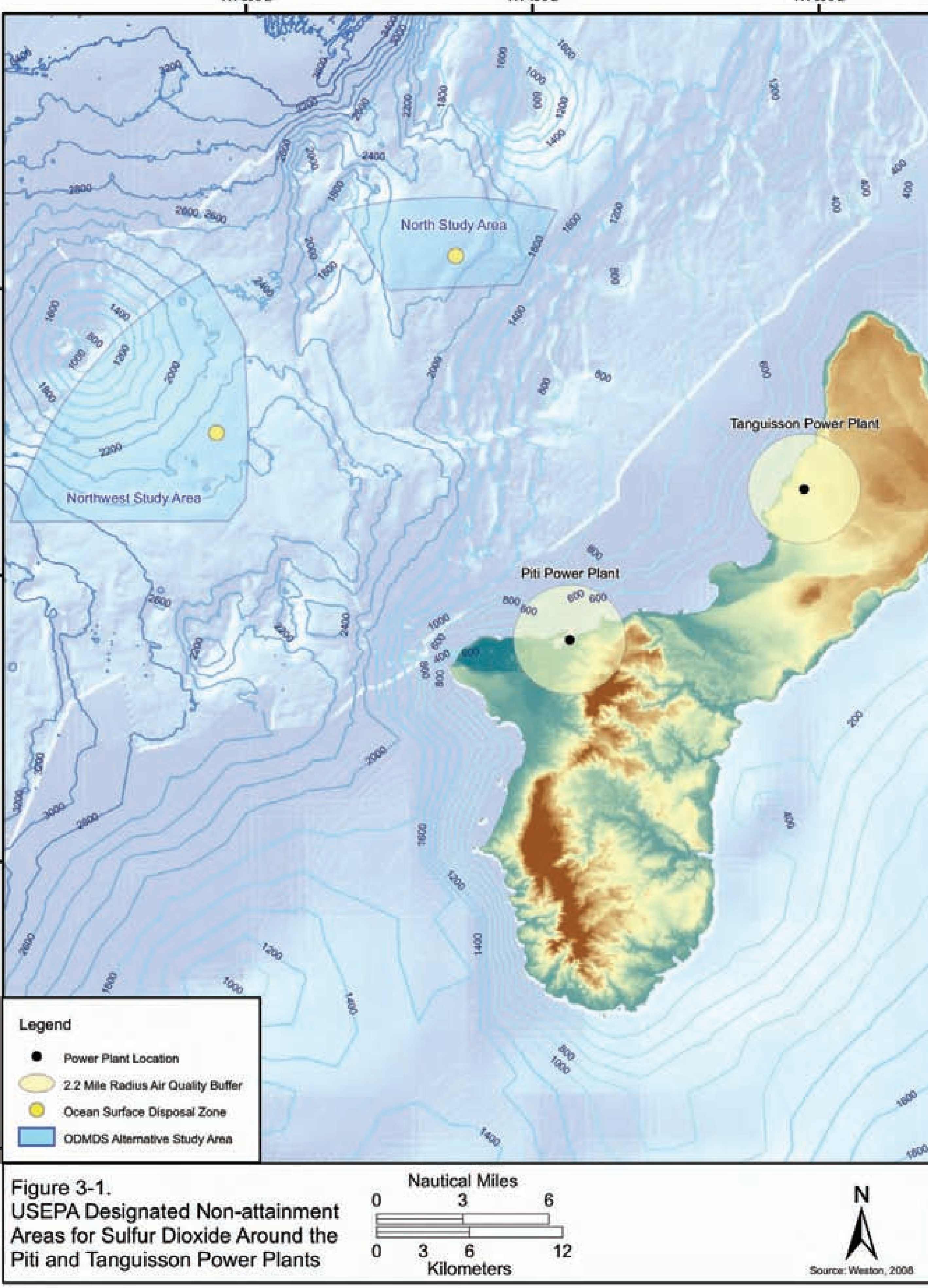

Figure 3-1.
USEPA Designated Non-attainment Areas for Sulfur Dioxide Around the Piti and Tanguisson Power Plants

3.1.2 Physical Oceanography

Oceanographic currents are distinguished by wind-driven surface currents in the upper portion of the water column and thermohaline currents in the intermediate and bottom layers of the oceans. Surface currents consist predominantly of the horizontal movement of water whereas vertical movement (i.e. upwelling or downwelling) resulting from density differences is characteristic of deeper waters.

Surface currents in the vicinity of Guam are dominated by the North Pacific Equatorial Current (NPEC), though coastal eddies may develop in the lee (westward side) of the island as a result of the NPEC flowing past Guam. The NPEC flows westward at an average speed of 0.33 to 0.66 ft/s (0.1 to 0.2 m/s; DON 2005) and reaching a maximum speed of approximately 0.98 ft/s (0.3 m/s; Wolanski *et al*. 2003) in response to trade winds typically occurring between 10° N and 15° N (Reid 1997). The strength and location of coastal eddies west of Guam are dependent on the angle at which the NPEC approaches and subsequently bifurcates around the island mass. These eddies are capable of producing eastward moving currents on the lee (westward side) of Guam (Wolanski *et al*. 2003).

Deep water currents in this region are dominated by the North Pacific Deep Water (NPDW) and the Lower Circumpolar Water (LCPW). The NPDW flows westward from the northeastern Pacific Ocean and the LCPW, after flowing northwestward across the equator east of Guam, branches into two limbs, a northward flow into the Pacific Basin and a westward flow towards the West Marianas Basin (Siedler *et al*. 2004).

The following sections describe the regional and ODMDS specific surface, intermediate layer and bottom currents from both modeled (satellite-derived) data and *in situ* (instrument-measured) data collection. The ROI for the following sections on oceanic currents is the water column within the ODMDS study areas.

3.1.2.1 Modeled Currents

Data generated from the global Navy Coastal Ocean Model (NCOM) was first used to evaluate currents surrounding the vicinity of the ODMDS alternative sites to determine consistency of regional current patterns and to understand the currents that dredged material may be subject to as a consequence of horizontal dispersion after the initial placement of material. The NCOM is an assimilative ocean model nowcast/forecast system developed and administered by the Naval Oceanographic Office (NAVO). Barron et al. (2007) discusses model validation using both observational data and other global ocean models for comparison. Detailed results of the modeled current data assessment are presented in the *Ocean Current Study, Ocean Dredged Material Disposal Site, Apra Harbor, Guam* (Weston Solutions and Belt Collins 2007b) and summarized briefly below.

Resolution of the model is 1/8°, or 7.5 x 7.5 nm. Input parameters for the model are satellite-measured sea surface temperature (SST) and sea surface height (SSH; altimetry) derived from the Modular Ocean Data Assimilation System (MODAS) and Navy Layered Ocean Model (NLOM), respectively. SST and SSH measurements are then used to project a vertical profile of temperature and density, from which thermohaline currents are derived. Thermohaline currents occur at depth and are driven by differences in density rather than wind patterns, which derive surface currents. Surface currents are derived from atmospheric conditions provided by the Navy Operational Global Atmospheric Prediction System (NOGAPS) which force NCOM predictions. Ocean depth and coastline boundaries used in the NCOM are based on a global dataset of two minute (1/30°) bathymetry data. Tidal currents were not incorporated in the model results.

Current data were provided for the entire 2005 calendar year. Data were provided for a 1° x 1° square area bounded by 14° N and 13° N latitude in the north and south, respectively and 145° E and 144° E longitude in the east and west, respectively. Thus, at the resolution of the model (1/8°), data were provided at 81 discrete locations. At each of these stations, data were provided for 17 separate depths. Currents were provided at finer (shorter) intervals near the surface with increasingly coarse (longer) intervals at deeper depths. At each station and depth, current data were provided for each six hour increment. Current data were provided as u (east-west) and v (north-south) vectors.

During processing of the text files, the individual vector data were used to calculate speed and direction for each location and depth. Rose diagrams representing the frequency distribution of current directions and speed for each depth at a single location and vector plots representing daily averaged current velocities at each location by month and depth were created. These plots provided a cursory review of the spatial (both horizontal and vertical) as well as temporal patterns in the data. Once patterns were identified, more quantitative statistical analyses were conducted using SAS software to identify significant trends or differences in the currents.

3.1.2.2 Regional Current Patterns

Surface Currents

During the fall and winter months (predominantly the dry season; Figure 3-2), surface currents tend to be quite uniform, having a significant west-northwesterly component across much of the study area. As the surface current approaches and bifurcates around Guam from the east, the currents in the southern portion of the study area tend to be more westerly, while currents in the northern portion of the study area tend to be towards the west-northwest. Once past Guam and beyond the site-specific study areas, these currents converge, with the currents in the southern portion of the study area trending more northwesterly and currents in the northern portion of the study area trending more westerly. This pattern creates an area of variable current patterns directly in the lee of the island, with surface currents capable of flowing back towards Guam on occasion. This pattern is most evident in February and March when the surface currents are highly uniform, however, it is also observed in the three preceding months (November through January) and one succeeding month (April).

In the summer months (predominantly the wet season; Figure 3-2), surface currents are slightly more variable on a month to month basis and the net current direction tends to flow in more southwesterly direction. During this time, the currents approaching Guam in the southern portion of the study area continue to be predominantly to the west, but having an increasingly greater southwesterly component through time such that currents approaching Guam in September are primarily trending to the southwest. The currents approaching Guam in the northern portion of the study typically trend towards the west-southwest, with directional variability being greater than those observed in the south during the same time period. In the lee of the island, the area of variable current patterns continued to persist.

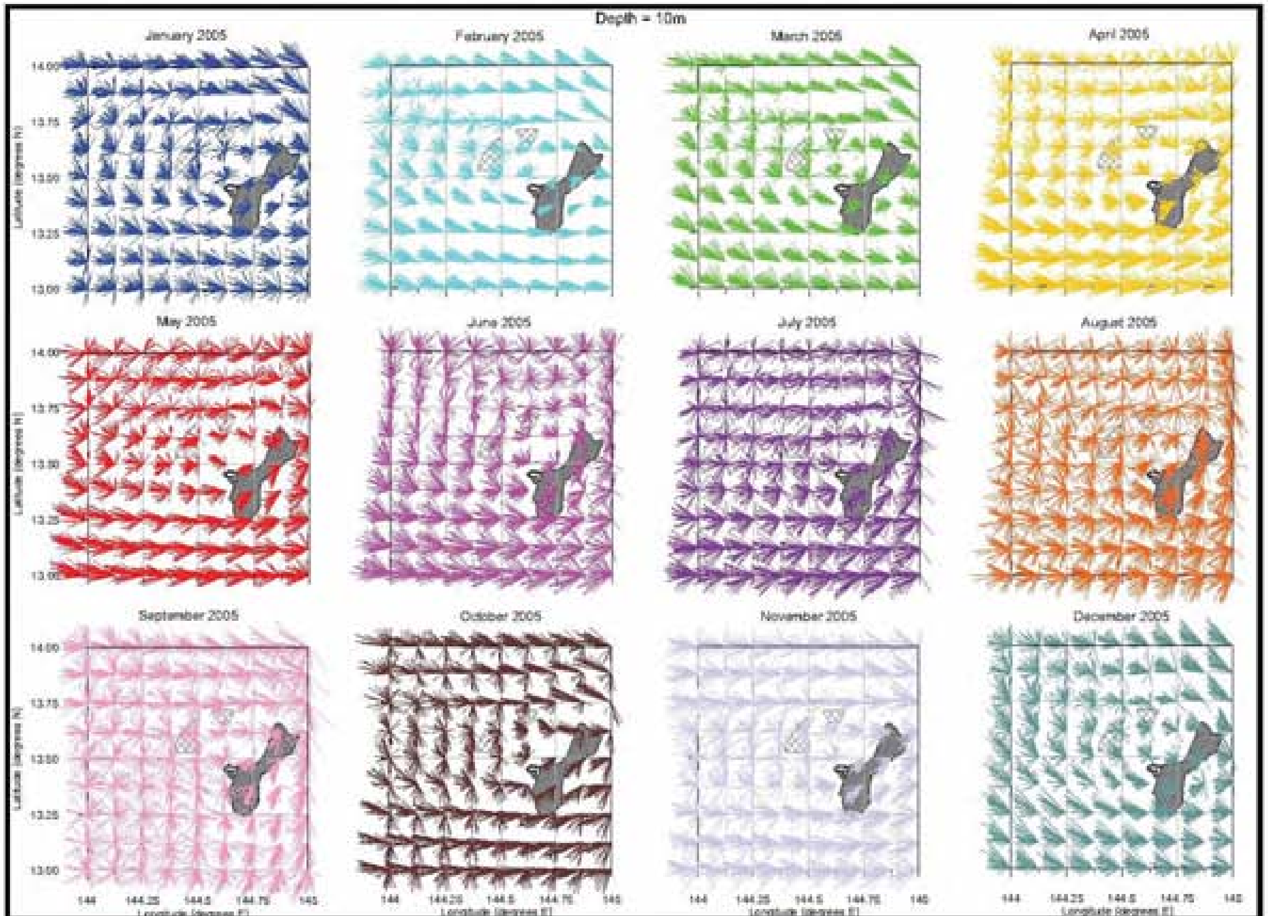

Figure 3-2.
Vector Plots of Daily Averaged Current Velocities by Month for Each Location at 33 ft (10 m) Depth

Intermediate Layer Currents

Figure 3-3 and Figure 3-4 illustrate the intermediate layer currents on a regional scale. Figure 3-3 shows the upper portion of this layer at 1,300 ft (400 m) and Figure 3-4 shows the lower portion of this layer at 4,900 ft (1,500 m). At 1,300 ft (400 m), seasonal differences in the current pattern are apparent, but negligible. Throughout most of the year, the currents approach Guam from the east, similar to the currents at the surface. At this intermediate depth, the currents begin to show evidence of flowing along the isobaths, with the structure of the Marianas Ridge influencing current patterns. Directly east and southeast of Guam, the currents trend in a southwesterly direction, then once past the southern part of the island, the currents uniformly turn towards the northwest. Along the western boundary of the regional study area, the currents are strong and towards the north. Directly on the west side of Guam, the currents wrapping around the southern tip of the island turn further, trending northeast and eventually returning to the eastern side of the island as they cross the Rota Banks, just north of Guam. Currents approaching northeast of Guam, north of the Rota Banks, flow in a uniform westerly direction.

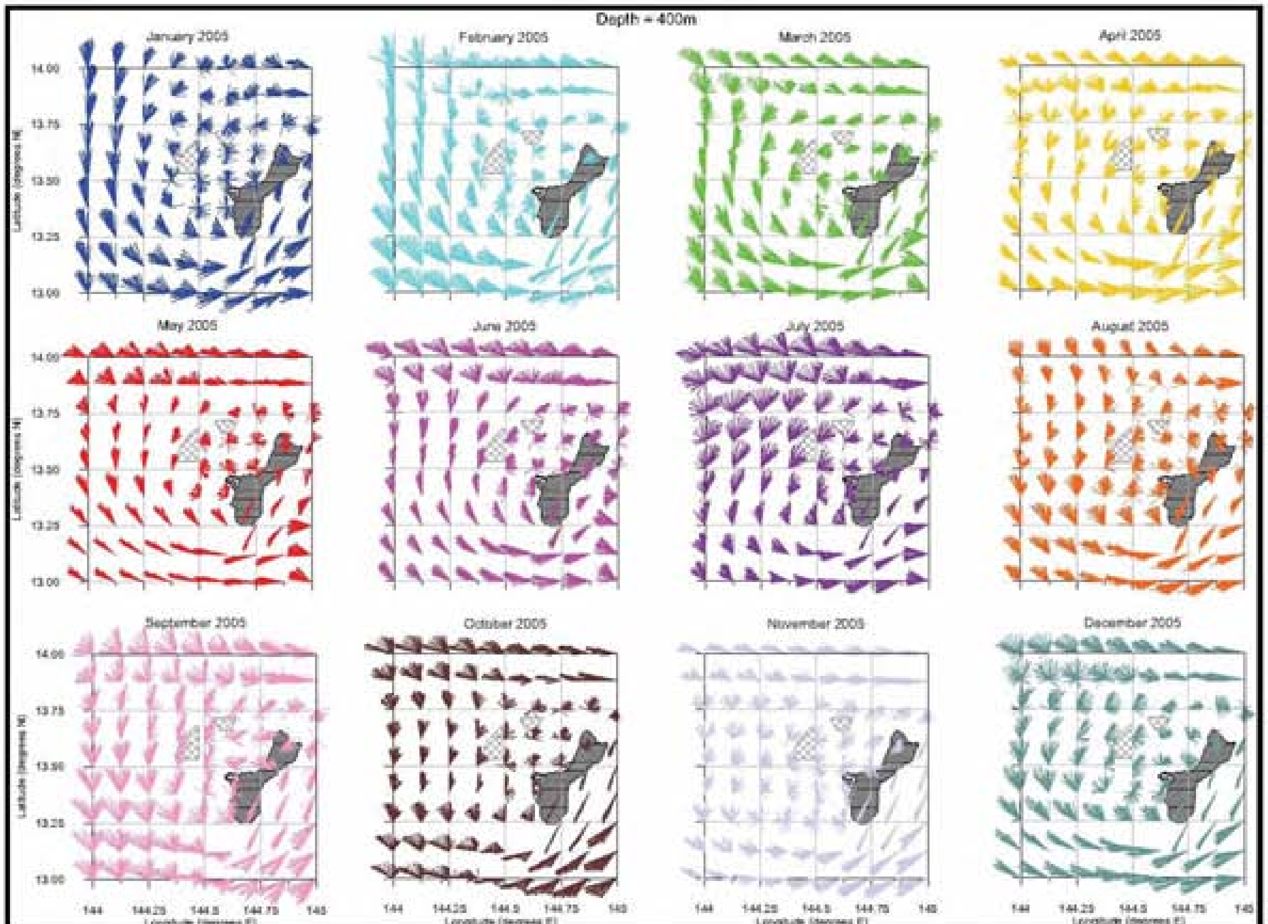

Figure 3-3.
Vector Plots of Daily Averaged Current Velocities by Month for Each Location at 1,300 ft (400 m) Depth

At 4,900 ft (1,500 m), there is no evidence of seasonal patterns. The Marianas Ridge, which trends from the southwest of Guam and continues towards the northeast is apparent and strongly influences the current patterns. On the east side of the Marianas Ridge, currents are highly uniform, trending in a southwesterly direction along isobaths at an average speed of 0.16 ft/s (0.05 m/s). It is not evident if the currents at this depth, approaching Guam from the Eastern Marianas Basin, flow through a gap in the ridge or if another water body is responsible for the currents on the west side of the Marianas Ridge; however, on the west side of Guam, currents at 4,900 ft (1,500 m) are also highly uniform, though flowing counter to the currents on the east side of the ridge, in a north-northeast direction along isobaths at an average speed of about 0.07-0.16 ft/s (0.02-0.05 m/s).

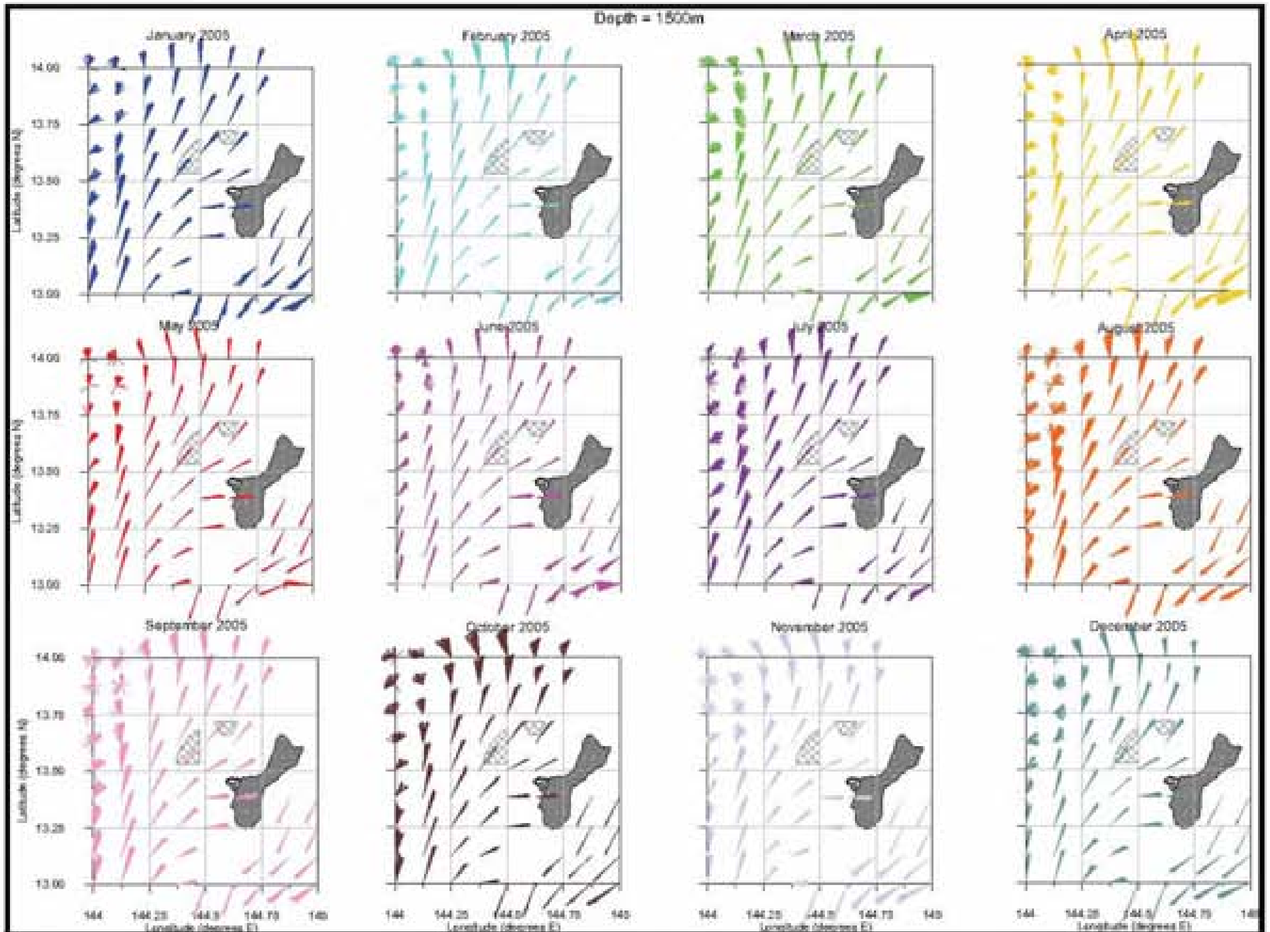

Figure 3-4.
Vector Plots of Daily Averaged Current Velocities by Month for Each Location at 4,900 ft (1,500 m) Depth

<u>Bottom Currents</u>

Figure 3-5 illustrates the bottom layer currents on a regional scale. Two distinct bottom currents are evident, depending on the relation to the Marianas Ridge. East of the Marianas Ridge, the bottom current below 8,200 ft (2,500 m) continued to be very uniform and trends in a southwesterly direction at an average speed of about 0.10-0.13 ft/s (0.03-0.04 m/s), flowing along isobaths, similar to the currents in the intermediate layer. West of the Marianas Ridge, there appears to be a poorly developed countercurrent relative to the intermediate layer with erratic currents, ranging from a north-northwesterly direction to a south-southwesterly direction, though areas with a predominant easterly component occur. Current speeds average about 0.03-0.07 ft/s (0.01-0.02 m/s).

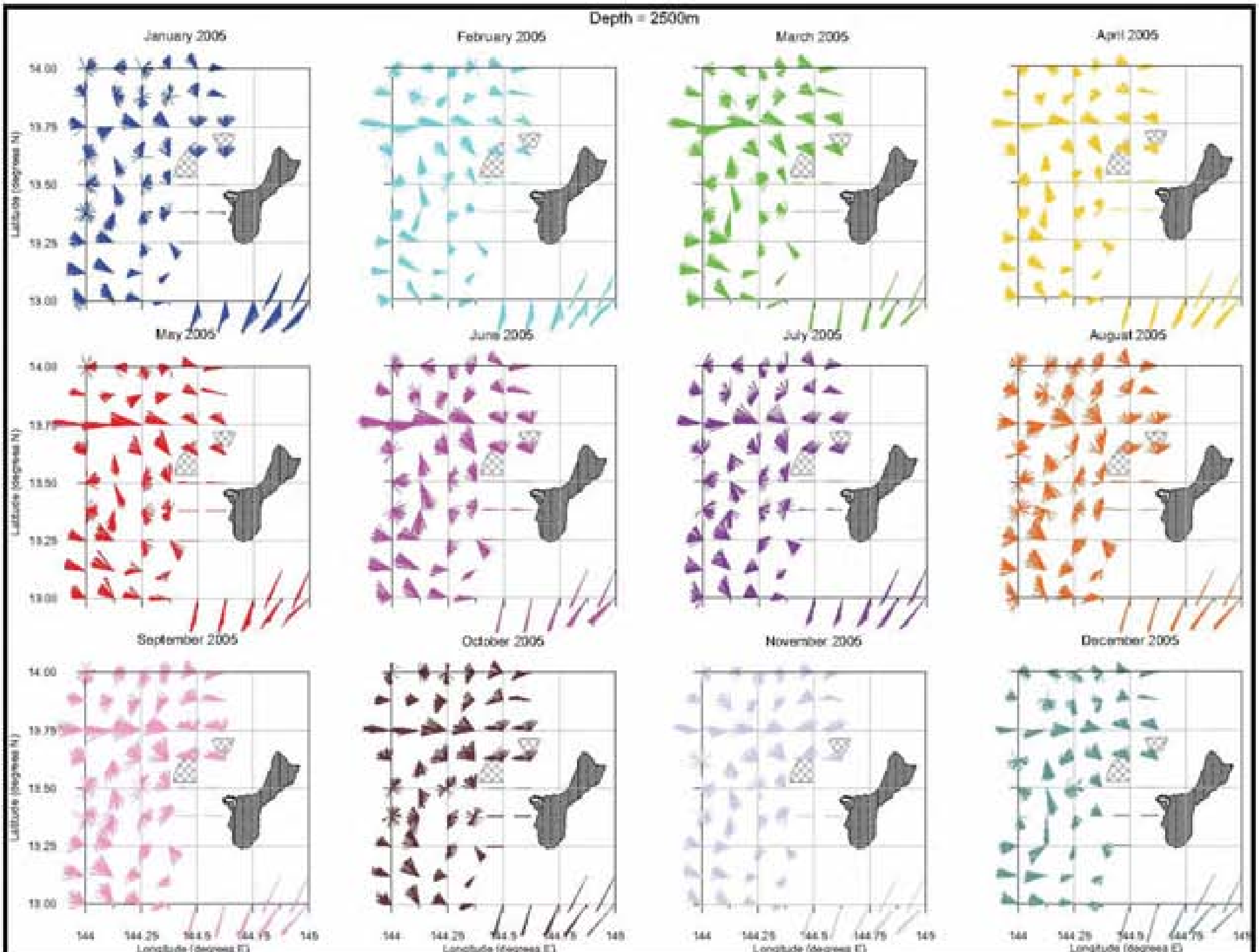

Figure 3-5.
Vector Plots of Daily Averaged Current Velocities by Month for Each Location at 8,200 ft (2,500 m) Depth

<u>North Alternative Study Area (Modeled) Current Patterns</u>

Surface currents at the North Alternative Study Area exhibit a more consistent pattern than those at the Northwest Alternative, having a stronger and more westerly component ranging from 0.08-0.30 ft/s (0.03-0.1 m/s). This is likely a result of its closer proximity to the uniform westward flows around the north side of the island. However, two to three week periods consisting of irregular, poorly developed currents occurred at this site. The southern portion of this site experiences greater variability than the northern portion. Intermediate layer currents (1,300 ft [400 m] to 6,550 ft [2,000 m]) at the North Alternative area trend towards the northeast with decreasing variability with increasing depth. Current speeds are about 0.10-0.16 ft/s (0.03–0.05 m/s) in the intermediate layer. The bottom currents (below 8,200 ft [2,500 m]) in the North Alternative area were fairly consistent, trending in a north-northwesterly direction at a speed of approximately 0.07 ft/s (0.02 m/s).

Northwest Alternative Study Area (Modeled) Current Patterns

Surface currents at the Northwest Alternative Study Area tend to be highly variable during most of the year, with periods of strong and consistent southward flowing pulses during the wet weather season. Intermediate layer and bottom currents at the Northwest Alternative area are similar to those modeled in the North Alternative area.

3.1.2.3 *In Situ* Currents

Arrays of four in-line current meters and one upward-looking current profiler were moored at two sites, CM1 and CM2 (Figure 3-6), for the purpose of recording surface, midwater, and bottom currents over a period of one year in the vicinity of the proposed ODMDS. In-line current meters were positioned at depths of approximately 1,000 ft (305 m), 3,281 ft (1,000 m), 5,702 ft (1,738 m), and at a depth of 328 ft (100 m) above the ocean floor (7,497 ft [2,285 m] at CM1 and 6,982 ft [2,128 m] at CM2). Current direction and velocity were logged by the current meters in 1-hour intervals. For determining the speed and direction of surface currents, a current profiler was located in-line with the current meters at a depth of approximately 492 ft (150 m) below the surface at each location. The current profiler logged surface current data (current velocity and direction) in 16.4 ft (5 m) intervals every 1 hour from the water's surface to a depth of 492 ft (150 m). Due to electrical problems in the current profiler installed at CM1, surface current data was not obtained at this site. Upper surface currents at CM1, to a depth of approximately 82 ft (25m), appeared to be predominantly wind driven and therefore were assumed to be similar to those measured at CM2. For ease in interpretation and discussion, vector speeds were averaged for each day of the year and plotted as speed and direction in vector plots. Vector plots of average daily mid-water and bottom currents at CM1 are provided in Figure 3-7 while vector plots of surface water, mid-water and bottom currents at CM2 are provided in Figure 3-8 and Figure 3-9.

CM1 Currents

Surface Currents- Depths of 0-82 ft (0-25 m)

It was assumed that sites CM1 and CM2 experienced similar current speeds and directions in their upper surface waters as a result of their close proximity to one another and as a result of the wind-driven nature of upper surface currents. Because surface current data were not collected at CM1, as previously mentioned, CM2 data were used to represent the uppermost surface conditions (82 ft (25 m) at both sites. During the months of January, February, March, and April 2008, the average daily currents measured at 82 ft (25 m) trended almost exclusively in a west, southwesterly direction with maximum velocities of 1.3 ft/s (0.40 m/s) (Figure 3-7). The upper surface currents then ran in a predominantly westerly direction in May and in a west, southwesterly direction in June. The months of July and August showed the greatest variability in current direction at 82 ft (25m) depth, trending from northeast to northwest to southwest and also had the highest measured current velocities (1.7 ft/s [0.54 m/s]). In September, the current direction ranged from northeast to southwest but trend predominantly in a southwest direction. In October through early December the upper surface currents returned to trending almost exclusively in a west, southwesterly direction. Speeds of the upper surface currents were slightly lower during the mid-summer (June and July) and mid-winter months (January and February) (average velocity= 0.89 ft/s [0.27 m/s]) than at other times of the year (average velocity = 1.1 ft/s [0.33 m/s]).